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(54) **Nonwoven fabric and method for production thereof**

(57) A non-woven fabric containing first and second fibres comprising first zones 23 extending the length of the fabric having a relatively high density and in which the first and second fibres are interlaced, the first zones being separated by second zones 29 of relatively low density in which the first fibres are substantially absent. The fabric may be formed by treating with fluid jets a layer of first fibres disposed on a layer of second fibres. Polyester polyolefine cotton and rayon fibres are specified.

02/03

1, 8, 9, 10 11, 12, 13, 14, 15-21, 24

FIG. 1

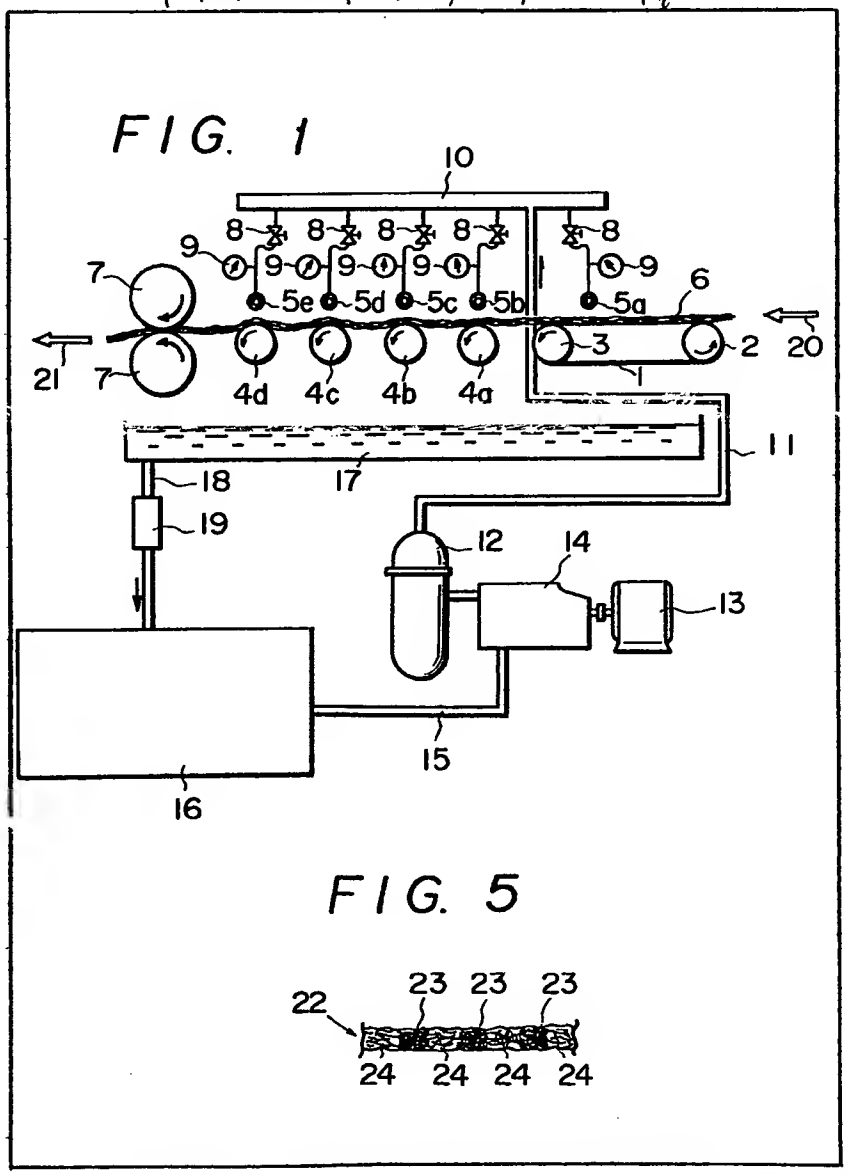

FIG. 5

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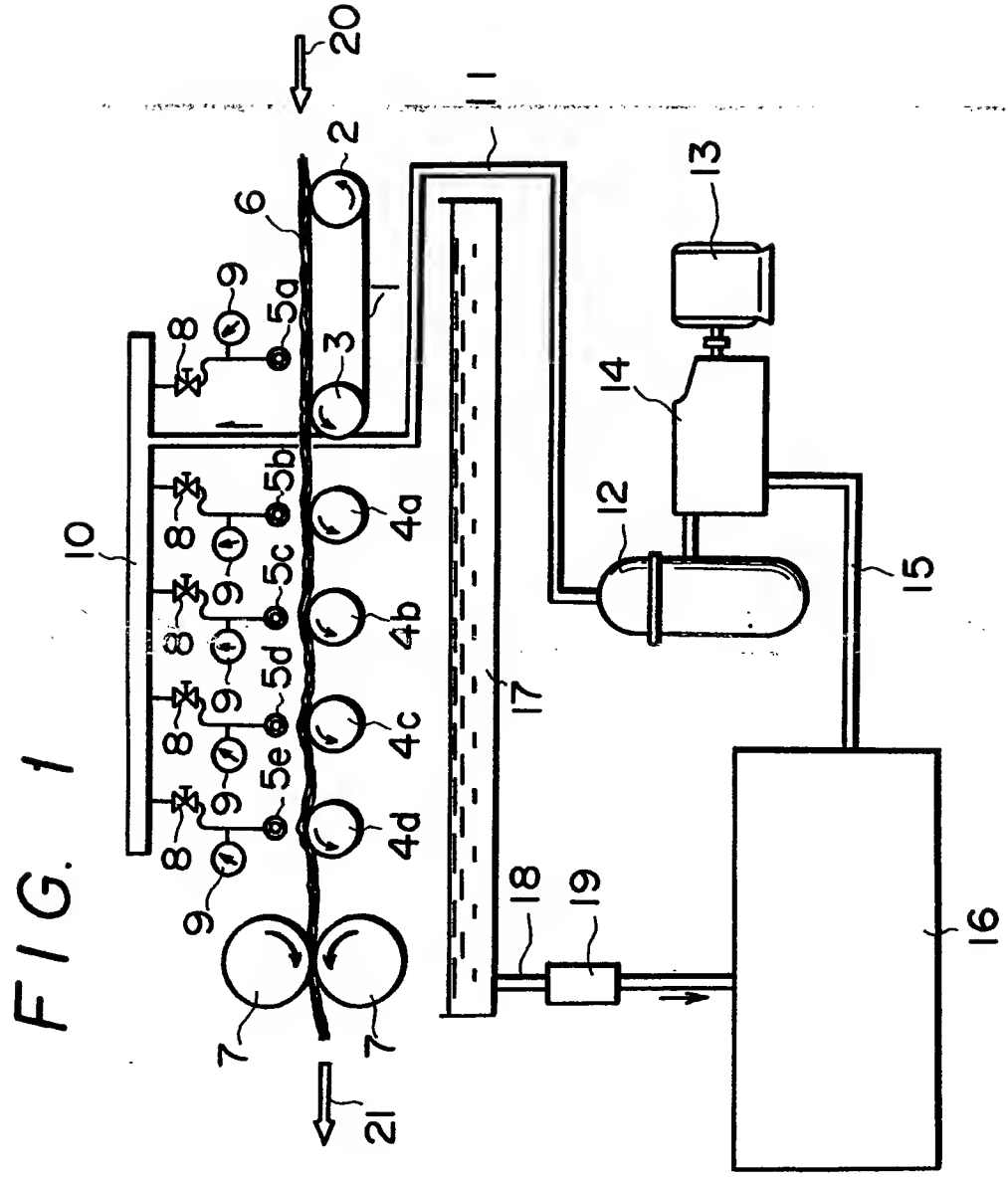


FIG. 1

FIG. 2

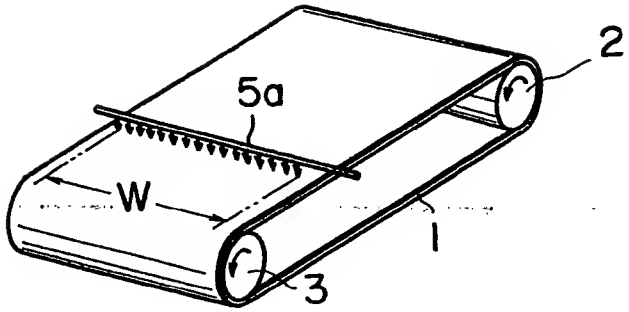


FIG. 4

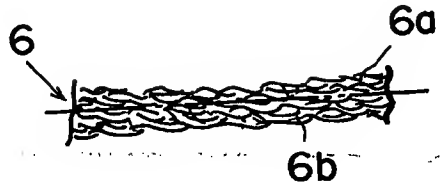


FIG. 3

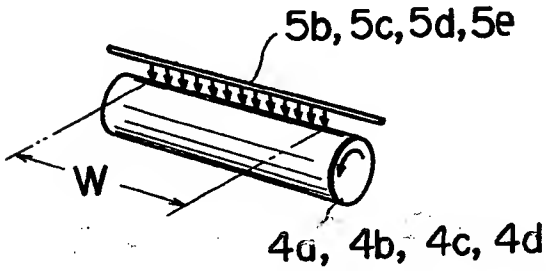


FIG. 5

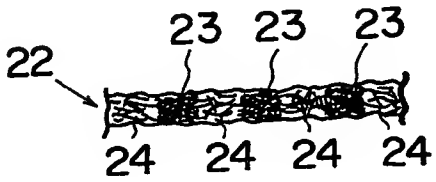


FIG. 6

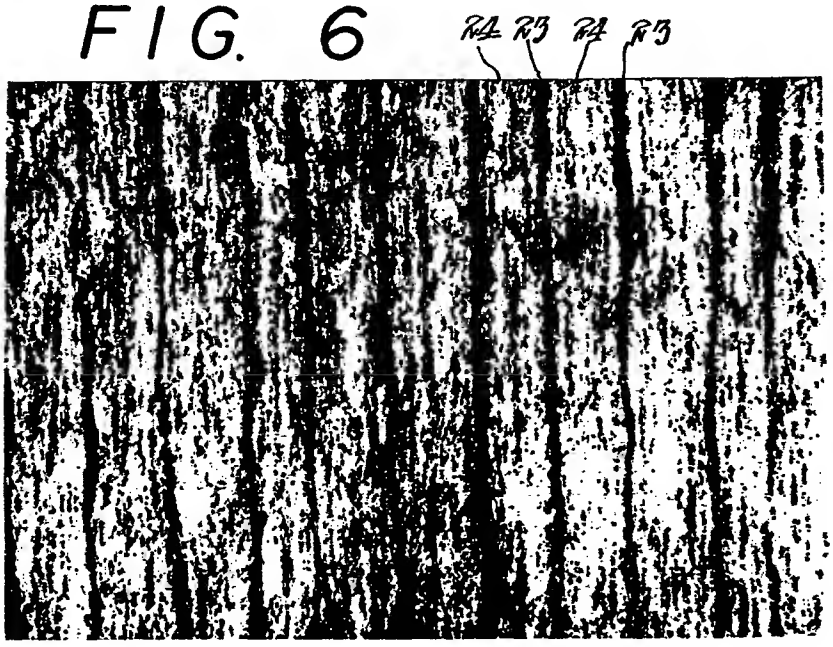


FIG. 7

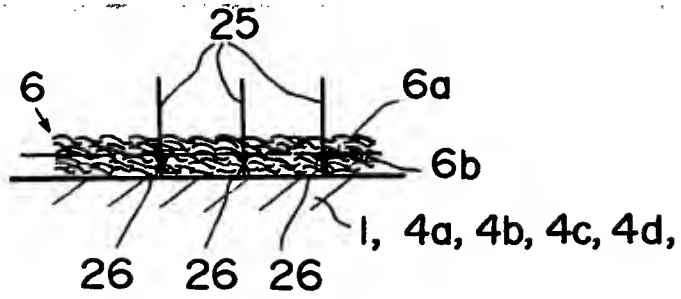
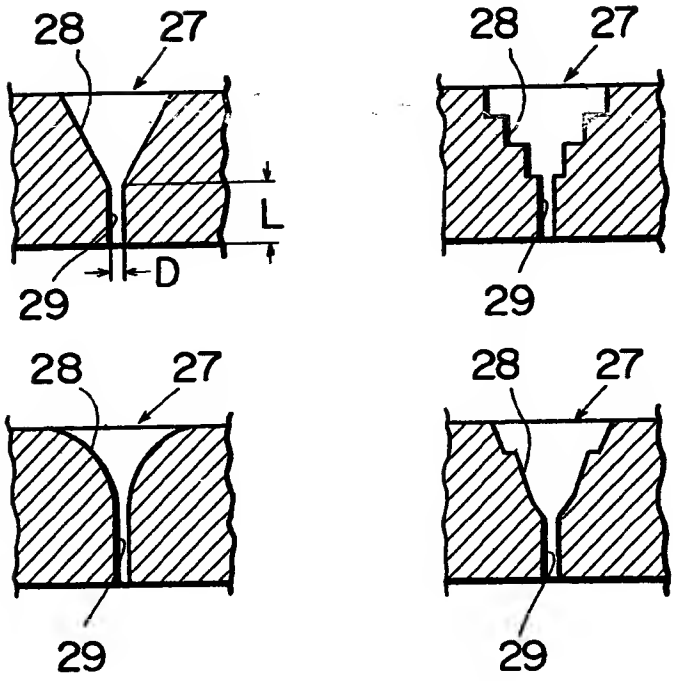


FIG. 8



SPECIFICATION

Nonwoven fabric and method for production thereof

The present invention relates to nonwoven fabric comprising alternately arranged stripe-like component zones having properties which are different relative to each adjacent zone and to a method for production of such nonwoven fabric.

It is well known to use nonwoven fabrics as material, particularly as the surface material for sanitary goods such as a sanitary napkin and a disposable diaper, and it has always been desired that these nonwoven fabrics conventionally used as the surface material should absorb a given quantity of body fluids at a given spot without diffusion thereof; should be kept dry even after passage of said fluids; and should prevent said fluids from flowing back. To satisfy these requirements, there have already been proposed and, in some cases, used in practice nonwoven fabrics of various types, for example, the nonwoven fabric comprising a mixture of hydrophilic fibres and hydrophobic fibres, the nonwoven fabric comprising a plurality of layers including hydrophilic fibre layers and hydrophobic fibre layers, and the nonwoven fabric comprising a hydrophilic fibre layer and a hydrophobic fibre layer, laid upon one another so that any one of these two layers is partially exposed through the other layer. However, all of these well known nonwoven fabrics have ever been unsatisfactory to meet said requirements and have disadvantages in aspects such as complicated steps and relatively high cost required for production thereof.

In accordance with the present invention, there is provided nonwoven fabric comprising alternately arranged stripe-like component zones having properties which are different relative to each adjacant zone. Such nonwoven fabric has the properties to meet said requirements that, when used as tha surface material in various sanitary goods, it should absorb a given quantity of various body fluids at a given spot without diffusion of such body fluids; it should be kept dry even after passage of said liquid therethrough; and it should prevent said liquid from flowing back. Further, the nonwoven fabric according to the present invention contains no special material such as fibre binding agent and, therefore, advantageously has comfortable bulkiness, fitness, air-permeability and warm touch. Thus, the nonwoven fabric of the presant invention is optimum, particularly as material for sanitary goods, as previously mentioned. In accordance with the present invention, the nonwoven fabric is formed not by using any speciel material such as fibre binding agent but only by utilizing a hydraulic energy of high velocity water streams for the fibre interlacing treatment and thereby the nonwoven fabric of said propertias is easily mass-produced at a low cost.

A principal object of the present invention is to provide the nonwoven fabric having said properties and the method for production thereof by which such nonwoven fabric can be produced at a low cost not by using any special material such as fibre binding agent but only by utilizing hydraulic energy of high velocity water streams.

Obviously, the method by which nonwoven fabrics are produced through a treatment under hydraulic energy of high velocity water streams has already been per se well known and the present invention does not intend to provide such treatment itself.

According to the present invention, there is provided nonwoven fabric comprising first component fibres and second component fibres, said nonwoven fabric being formed of

(1) the first zones arranged parallel at intervals transversely of said nonwoven fabric and respectively being continuous longitudinally of said nonwoven fabric and having a relatively high density, in which said first component fibres and said second component fibres are interlaced with each other; and

(2) the second zones interposed between each pair of said first zones and having a relatively low density, in which said second component fibres are present and said first component fibres are scarcely contained.

The present invention provides also a method for production of such nonwoven fabric, said method comprising a step of subjecting the materials to be treated, i.e., the component materials of nonwoven fabric to a hydraulic energy of fine water jet streams supplied from orifices arranged at desired pitches onto a water-impermeable support on which said materials to be treated are placed and thereby the desired nonwoven fabric is formed.

The invention will now be further described by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a side view schematically illustrating an apparatus for execution of the method according to the present invention;

Fig. 2 is a perspective view illustrating a first support;

Fig. 3 is a view similar to Fig. 2 illustrating a second support;

Fig. 4 is a sectional view schematically illustrating a structure of the materials to be treated;

Fig. 5 is a sectional view schematically illustrating how the first component fibras are combined with the second component fibres of the materials to be treated;

Fig. 6 is a photograph showing on an enlarged scale the structure of a nwoven fabric obtained by the method according to the present invention;

Fig. 7 is a sectional view schematically illustrating a principl of the high velocity water streams

acting upon th materials to be treated; and

Fig. 8 is a vertical section illustrating an embodiment of the orifice arrang ment.

Ref rring to Fig. 1, an endless belt 1 serving as e first support which is water-impermeabl and has a substantially smooth surface is suspended on and extends b tween a pair of rolls 2, 3. Th re are erranged at th left side as se n in Fig. 1, rolls 4a, 4b, 4c, 4d serving as second supports and respectively having water-impermeable and substantially smooth surfaces. Above said belt 1 and the rolls 4a, 4b, 4c, 4d, there ere correspondingly arranged nozzle means 5a, 5b, 5c, 5d, 5e (Figs. 2 and 3). There is arranged at the left side as seen in Fig. 1 a pair of squeezing rolls 7 for dehydration of the materials 6 to be treated. The respective nozzle means 5a, 5b, 5c, 5d, 5e are connected via associated pressure regulating valves 8 and pressure gauges 9 to a distribution reservoir 10. The distribution reservoir 10 is connected by a pipe 11 to a filter reservoir 12 which is, in turn, connected to a pressure pump 14 adapted to be driven by a motor 13. Said pump 14 is connected by a pipe 15 to a reservoir 16. In a space defined under the belt 1 and the rolls 4a, 4b, 4c, 4d, 7 there is arranged e try-like recovery tank 17 which is connected via a pipe 18 and a filter box 19 to the reservoir 16. A quantity of water within the reservoir 16 is pressurized by the pressure pump 14, filtered by the filter reservoir 12, supplied to the distribution reservoir 10, then distributed into the respective nozzle means 5a, 5b, 5c, 5d, 5e and finally jetted out through the respective orifices arranged in the bottoms of these nozzle means at desired intervals onto the associated belt 1 end rolls 4a, 4b, 4c, 4d, 4e in the form of high velocity fine water streams (Figs. 2 and 3).

In this apparatus, the materials 6 to be treated are introduced in the direction of an arrow 20 onto the belt 1 and then transported in the direction of an arrow 21 successively on the belt 1, the rolls 4e, 4b, 4c, 4d, 4e and through the squeezing rolls 7. The materials 6 to be treated are first subjected to a preliminery treatment for fibre interlacing with the high velocity water streams jetted through the orifices of the nozzle means 5a as said meterials 6 ere transported on the belt 1 so that the materials 6 are bestowed with a sufficient fibre interlacing effect to prevent the fibrous webs referred to below from being disturbed in its configuration or being damaged. The materials 6 to be treated are successively subjected to similer but more intensive treetment with the high velocity water streams jetted out through the orifices of the respective nozzle means 5b, 5c, 5d, 5e as said meterials 6 are transported on the rolls 4a, 4b, 4c, 4d. After these preliminary and regular treatments for fibre interlacing, the materials 6 are squeezed by the rolls 7 to the extent that said materials 6 becomes substantially free from moisture and are transferred to the subsequent process for drying.

Fig. 4 illustrates a structure of the materials 6 to be treated by the method eccording to the present invention. The meteriels 6 to be treated comprise a first component fibrous web 6a and a second component fibrous web 6b laid upon one another. The first component fibrous web 6a may be formed by a card or a paper making machine so far es fibres can be displaced under the high energy of the jet streams. However, the basic weight of the first component fibrous web 6a must be less then 50 g/m² and preferably less than 25 g/m². With a basic weight of 50 g/m² or heavier, it would be impossible to distinguish first component zones end second component zones, which will be described later. The second component fibrous web 6b also may be formed by a card or a paper making mechine or other means so far as fibres can be displaced by the force of the jet streams towards the second component fibrous web 6b. Although the basic weight of the second component fibrous web 6b is not important, it is preferred that the first component fibrous web 6a and the second component fibrous web 6b totally should have a basic weight less than 100 g/m². The present invention utilizes the first component fibrous web 6a and the second component fibrous web 6b, for example, in combination as shown by the following table, where A represents the hydrophilic fibres and B represents the hydrophobic fibres.

	1	2	3	4	5	6
First component fibrous web	A	B	A	B	AB	AB
Second component fibrous web	B	A	AB	AB	A	B

When a mixture of the hydrophilic fibres and the hydrophobic fibres is used, a mixing ratio (% by weight) may be selected depending on a particuler application of the nonwoven fabric to be obtained. Where the nonwoven fabric is used as surface material for a sanitary napkin or disposabl diaper, for xampl , it has proved to be effective that the first compon nt fibrous web 6a comprises a mixture of rayon fibres of 50% by weight end poly ster fibr s of 50% by weight whil th s cond comp n nt fibrous w b 6b comprises poly ster fibres of 100% by w ight r the first component fibrous w b 6a compris s a mixture of rayon fibres of 50% by weight and cotton fibres of 50% by weight whil the second component fibrous web 6b comprises a mixture of polyest r fibres of 50% by weight and polypropylene fibres of 50% by weight.

Figs. 5 and 6 illustrate the nonwoven fabric btained by th method according to the present invention. The materials 6 to be treated comprising the first component fibrous web 6a as th upper layer laid upon the sec nd c mponent fibrous web 6b as th low r layar ar introduced into th apparatus of Fig. 1, in which the materials 6 are subj cted, on the belt 1 and th rolls 4a, 4b, 4c, 4d serving as said first support and said sacond support, respectiv ly, to tha fibre interlacing treatment with the high velocity water streams jetted out through tha orifices arranged at a desired pitch in the bottoms of tha respective nozzla means 5a, 5b, 5c, 5d associated with said balt 1 and said rolls 4a, 4b, 4c, 4d, respectivaly, so that tha first zones 23 and the second zones 24 of the nonwoven fabric 22 are formed. Tha first zones 23 are arranged at intervals corresponding to tha pitches of said orifices transversely of tha nonwoven fabric 22 and continuously extend longitudinally of the nonwoven fabric 22 while the second zones 24 are interposed between each pair of said first zones 23. In the first zones 23, tha fibres in the first component fibrous web 6a ara displaced in the direction of thickness of tha second component fibrous web 6b and the fibres in the first component fibrous web 6a and the fibres in tha second component fibrous web 6b are intarlaced with each other and thereby the first zones have a relatively high density. In the second zones 24, on tha contrary, the fibres in tha first component fibrous web 6a are scarcely present by virtua of being displaced into tha first zones 23 and thereby tha second zones have a relatively low density. In order that the first zones 23 and the second zones 24 may be distinguished from one another, the basic weight of tha first componant fibrous wab 6a must be less than 50 g/m², as already mentioned. The dlameter of aach orifice is preferably 0.05 to 0.2 mm and the pitch at which the orifices ara arranged is preferably 0.5 to 10 mm to form the first zones 23 and the second zones 24 which are clearly distinguished from one another. In the embodiment as illustrated by Figs. 5 and 6, the first zones 23 are relatively narrow while the second zones 24 are relatively wide, but the present invention is not limited to this embodiment. However, it has proved to be preferable that the first zones 23 are narrower than or substantially aqual to the second zones 24 when tha nonwoven fabric is used as the surface material for a sanitary napkin or disposable dlaper and comprises hydrophilic fibres of 50% by weight as tha fibres in tha first component fibrous web 6a and hydrophobic fibres of 100% by weight as the fibres in tha second component fibrous web 6b, since such composition contributes to an improvament of said propertias desired for tha nonwoven fabric, i.e., the properties to meet the requirements that the nonwoven fabric should effectively absorb the body fluids at a given spot, remain dry even after passage of said fluids and prevent said fluids from flowing back.

Fig. 7 principally illustrates the manner in which the high velocity water streams behave during tha treatment for fibres interlacing on the belt 1 and tha rolls 4a, 4b, 4c, 4d. The high velocity water streams 25 penetrate the materials 6 to be treated, strike against the surface of the associated supports, i.a., said belt 1 and said rolls 4a, 4b, 4c, 4d, and rebound thareon upwards to act again upon said materials 6 to be treated. The materials 6 to ba treated are thus subjacted to interaction of the water jat streams 25 and their rebounding streams 26 so that the individual fibres in said matarials to be treated are displaced in three-dimensional directions and thereby complicatedly, firmly and efficiently interlaced. The water streams which have lost their energy upon completion of the fibre interlacing treatment are drained along peripheries of the respective supports and partially along adgas of the materials 6 to be treated which are travelling, tha streams being drained into said recovary tank 17. Surface hardness of the respective supports must be sufficiently high so that tha high velocity water streams may rebound on the surfaces of the respective supports and these rebounding streams may contributa again to the treatment for fibre interlacing. Accordingly, tha belt 1 as said first support and the rolls 4a, 4b, 4c, 4d as said second supports should hava thair surface hardness, in accordance with the present invention, higher than 50°, preferably higher than 70° according to JIS (the Japanese Industrial Standards)—K 6301 Hs. Said belt 1 and said rolls 4a, 4b, 4c, 4d may be made of metal, rubber or plastics or a combination thereof, so far as they have said hardness and a strength enough to resist a pressure of the high velocity water streams. Each of said rolls 4a, 4b, 4c, 4d preferably has a dlameter of 50 to 300 mm to resist the pressure of the high velocity water streams and to facilitate the drainage thereof.

Fig. 8 illustrates by way of example a structure of each orifice 27 formed in tha bottom of each nozzle means 5a, 5b, 4c, 5d, 5a. The orifice 27 has a diameter 0.05 to 0.2 mm and comprises, in its vertical section, a downwardly taparing portion 28 and a linear portion 29 as sean in Fig. 8(A), (B), (C) and (D). L/D, a ratio of a length L to a diameter D of said portion 29 is smaller than 4/1, more preferably smaller than 3/1. Such configurations of the orifice 27 contributes to effective reduction of a pressure loss due to the water stream resistance. On the contrary, the orifice 27 in the form of a uniform diameter cylindar with said ratio L/D larger than 4/1 would result in an increase of the pressure loss due to the water stream resistance and a considerable economical disadvantage.

A transverse average supply of the high v locity wat r streams from th respective nozzle means 5a, 5b, 5c, 5d, 5 having th orifices 27 as illustrated by Fig. 8 onto the associated supports is l ss than 40 cc/s c·cm, more praferably, less than 30 cc/sec·cm. Tha valua expressed harein by "transvarse average supply" is giv n by a ratio F/W where F repres nts a total flux jetted out from ach of the nozzl means onto one support, i.e., each of the belt 1 and tha rolls 4a, 4b, 4c, 4d as shown in Figs. 1 through 3 and W represents an ffective width of ach nozzle means 5a, 5b, 5c, 5d, 5e. Wh n treated with said transverse average supply of 40 cc/sec·cm or higher, the high v locity water str ams jett d onto the

belt 1 and th rolls 4a, 4b, 4c, 4d would be inadequately drained and the mat rial to b tr ated would be flooded with an xcess of water. In consequence, th nergy of the high velocity water streams which is expected to act upon the mat rial to be treated would be suddenly reduced and the desired treatment for fibre interlacing would be seriously obstructed or th stability with which the fibrous web should be treated would be reduced, if the material 6 to be treated contains therein such fibrous web, since said fibrous web would be disturbed.

A pressure at which the high velocity water streams are jetted out, more strictly, a back pressure of the nozzle means 5a, 5b, 5c, 5d, 5e is lower than 35 kg/cm², more preferably, 15 to 30 kg/cm². At the back pressure of 35 kg/cm² or higher, the individual fibres in the material 6 to be treated would be displaced so far that the structure of this fibrous web is disturbed and the fibre interlacing would be uneven. At the back pressure lower than 7 kg/cm², on the contrary, it would be impossible to produce the nonwoven fabric of the desired properties at a high efficiency, no matter how long the material to be treated is subject to the treatment with the high velocity water streams or no matter how close to the material to be treated said nozzle means are placed.

Although the present invention has been described hereinabove with reference to the nonwoven fabrics to be used as material for sanitary goods and the method for production of such nonwoven fabrics, it should be understood that the method according to the present invention may be applied to production of various nonwoven fabrics comprising, as component with properties different relative to each other, an electrically conductive component and an electrically insulative component, a dyeable component and a non-dyeable component, components of different melting points, a fusible component and an infusible component, components of different elasticities, or an elastic component and an inelastic component, depending upon the intended uses of the nonwoven fabric to be obtained.

EXAMPLE

Rayon fibrous web (1.5 d x 51 mm) of 10% by weight as the first component fibrous web and polyester fibrous web (1.4 d x 44 mm) of 100% by weight as the second component fibrous web were laid on one another to obtain materials to be treated of a basic weight equal to 20 g/m². Such materials to be treated were introduced into the apparatus as illustrated in Fig. 1, in which said materials were treated at a jet pressure of 30 kg/cm² and a transverse average water supply of 8.5 cc/sec·cm of the high velocity water streams from the respective nozzle means 5a, 5b, 5c, 5d, 5e onto the supports 1, 4a, 4b, 4c, 4d as shown in Figs. 1 to 3, to obtain samples of nonwoven fabric. These samples were immersed in a boiled 1% solution of dyes which are available under the trade name "KAYASTAIN A" from NIHON KAYAKU CO., LTD., in Japan, with a result that the rayon fibres were dyed in yellow and the polyester fibres were dyed in blue. These samples exhibited characteristics as shown in the following table.

Samples No.	B.W. of 1st component fibrous web (g/m²)	Total b.w. (g/m²)	Remarks
1	10	29.8	1st zones were formed
2	20	37.6	"
3	50	68.7	1st and 2nd zones were not clearly distingulshed

CLAIMS

1. A nonwoven fabric comprising first component fibres and second component fibres having properties which are different from each other, said nonwoven fabric comprising

(1) first zones arranged parallel at intervals transversely of said nonwoven fabric and respectively being continuous longitudinally of said nonwoven fabric and having a relative high density, in which said first component fibres and said second component fibres are interlaced with each other; and

(2) second zones interposed between each pair of said first zones and having a relatively low density, in which said first component fibres are scarcely present.

2. A nonwov n fabric as claimed in claim 1, wherein the first component fibres c mpris hydr philic fibr s, and the second component fibres comprise hydrophobic fibres.

3. A nonwoven fabric as claimed in claim 1, wherein the first component fibres c mpris hydrophobic fibres, and the second component fibres comprise hydrophilic fibr s.

4. A method for the productl n of a n nwov n fabric comprising a step of subjecting materials to be treated consisting of a first compon nt fibrous w b and a second component fibrous w b laid upon one another to a treatm nt with high v locity fine wat r str ams j tted ut through rifices of nozzl

m ans at a pressure lower than 35 kg/cm² onto water-impermeable supports, the respective nozzle means being so provided that said orifices of the associated nozzle means are arranged at desired pitch s transv rsely of said materials to be treated and opposed to said first component fibrous web of said materials to be treated in such a manner that the first zones are formed at intervals corresponding to the pitches of said orifices transversely of the nonwoven fabric and continuously extend longitudinally of said nonwoven fabric, in these first zones the fibres in said first component fibrous web being displaced in the direction of thickness of said second component fibrous web and the fibres in said first component fibrous web and the fibres in said second component fibrous web being interlaced with each other; and that the second zones are formed between each pair of said first zones, in these second zones the fibres in said first component fibrous web being scarcely present by virtue of being displaced into said first zones.

5. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres, and the second component fibrous web comprises hydrophobic fibres.

6. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres.

7. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres, and the second component fibrous web comprises hydrophilic fibres and hydrophobic fibres.

8. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres and hydrophobic fibres.

9. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres and hydrophobic fibres, and the second component fibrous web comprises hydrophilic fibres.

10. A method as claimed in claim 4, wherein the first component fibrous web comprises hydrophilic fibres and hydrophobic fibres, and the second component fibrous web comprises hydrophobic fibres.

11. A non-woven fabric as claimed in claim 1, and substantially as hereinbefore described with reference to Figs. 5 and 6 of the accompanying drawings.

12. A method as claimed in claim 4 and substantially as hereinbefore described with reference to the Example.

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